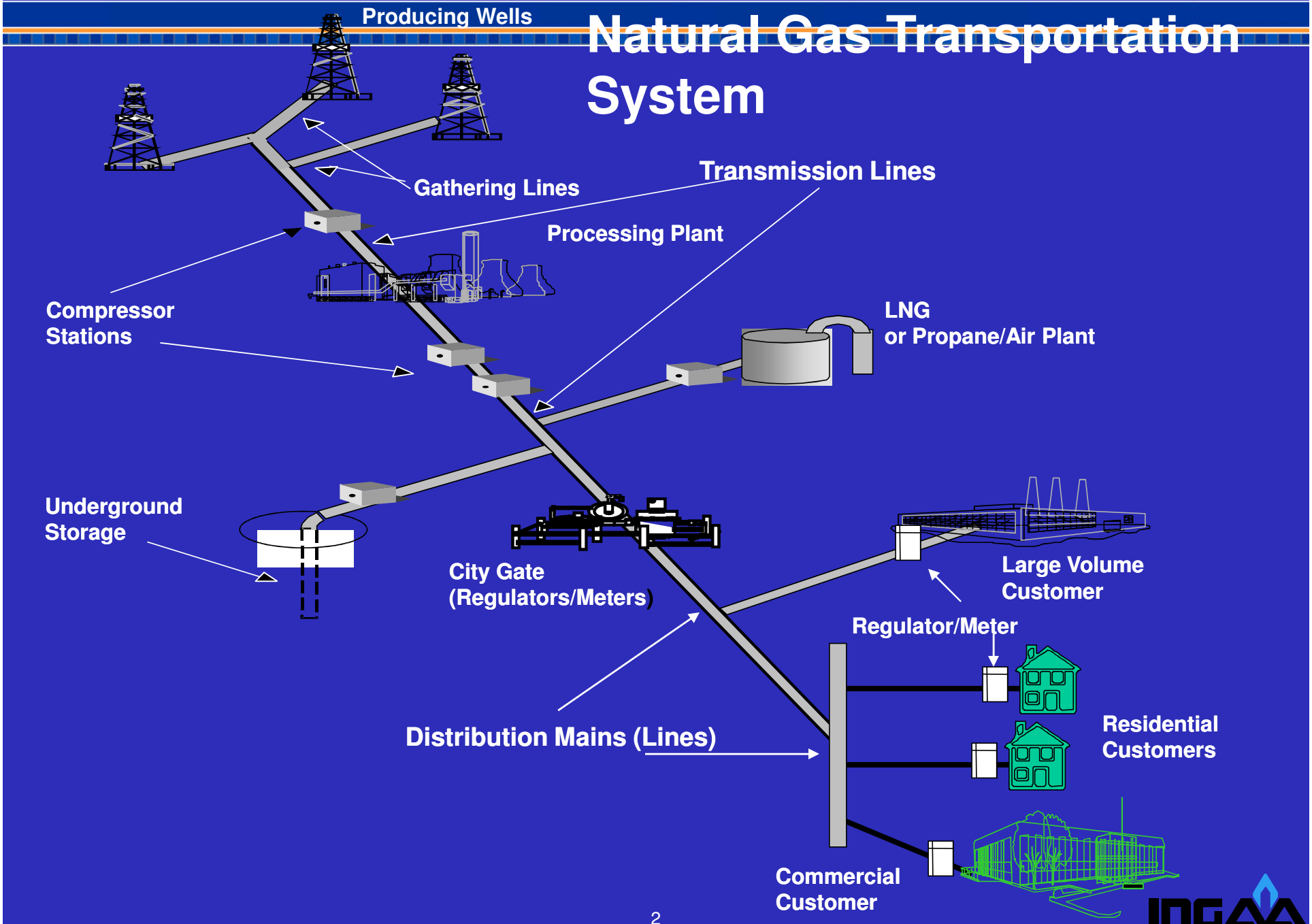
Interstate Natural Gas Association of America

CCS Transport
Barriers to Widespread Deployment

May 6, 2010

Contact
Lisa Beal, Interstate Natural Gas Association of America
Director, Environment and Construction Policy
lbeal@ingaa.org or 202-216-5935

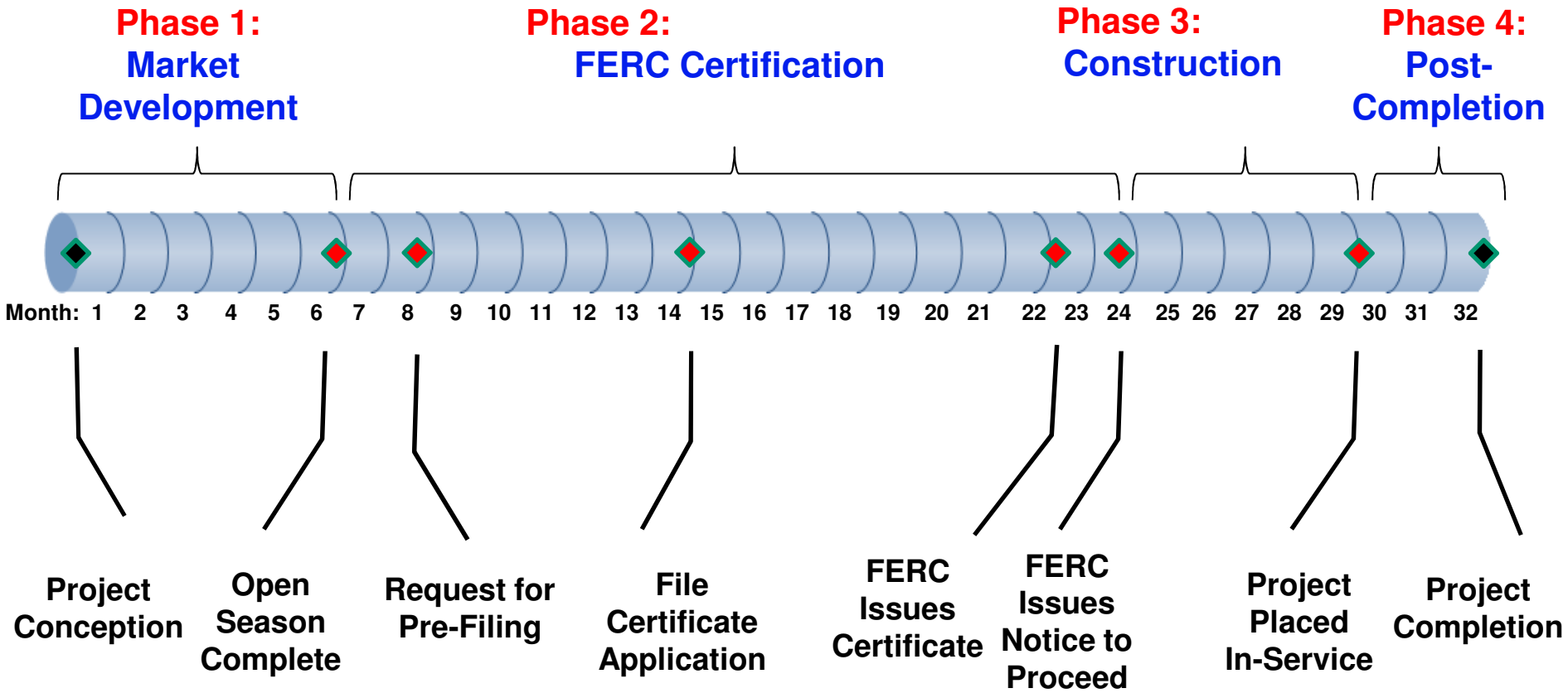
Natural Gas Transportation System



Introduction – INGAA & Pipeline Industry

- INGAA member companies transport over 90% of the nation's natural gas through a network of 220,000 miles of pipelines.
- INGAA member companies operate over 6,000 stationary natural gas-fired engines and 1,000 stationary natural gas-fired combustion turbines at compressor stations “facilities”
- INGAA members have enjoyed a relatively successful history of siting mainly due to the existence of a lead Federal agency, the Federal Energy Regulatory Commission. But there are issues
  - Highly capital intensive
  - Complex and long-term commercial, legal, financial, engineering and operational arrangements
  - Crosses multiple states and regulatory jurisdictions
- Between January, 2000 and April 2010 there were approximately 15,000 miles of Transmission projects certificated compared to just 1,000 miles of electric transmission.
  - What model will CCS follow?

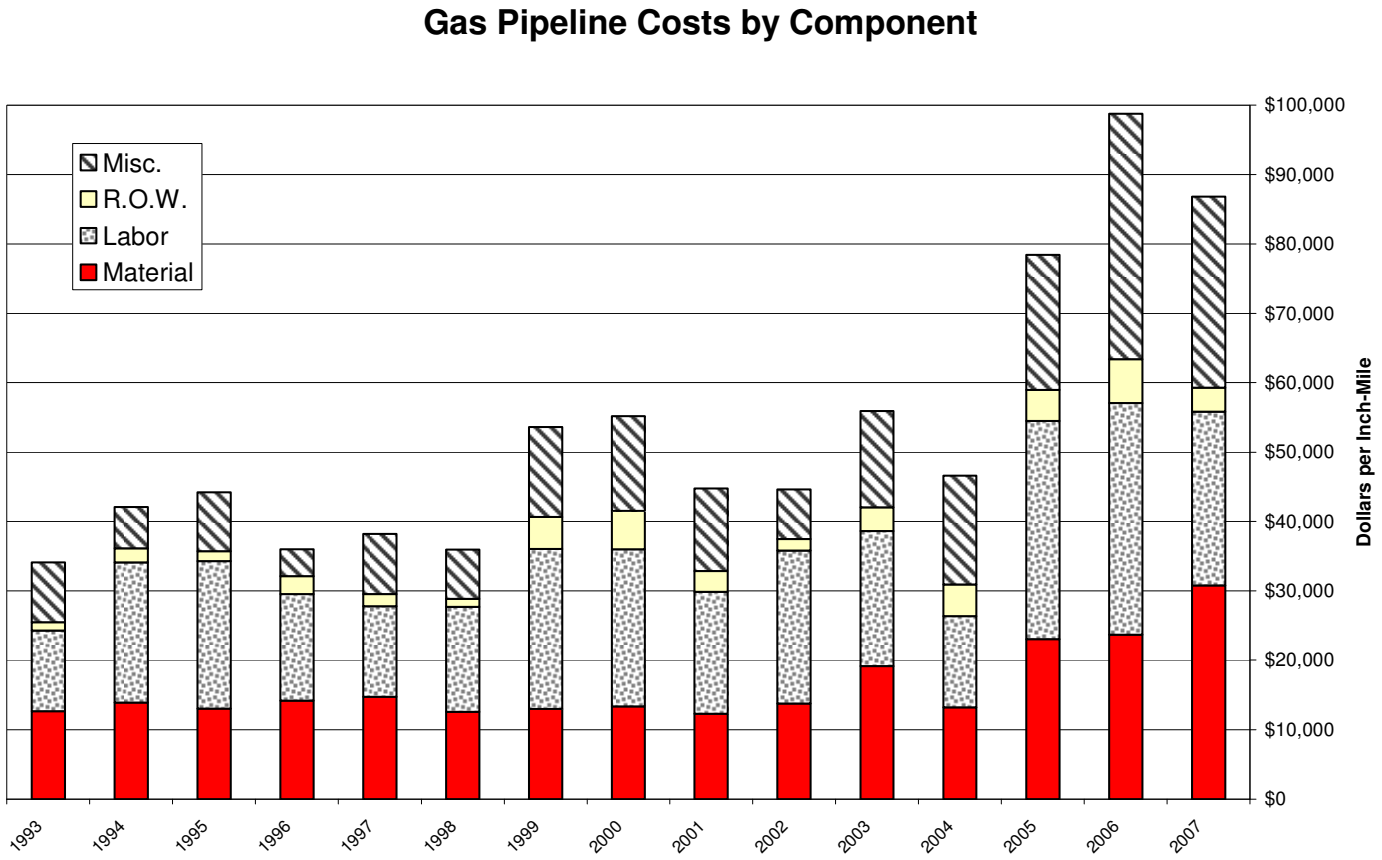
Project Execution Spans Four Phases



Pipeline Transport Costs

- The estimated construction cost of a pipeline in the US is about $ 75,000/inch/mile. However, this cost is greatly influenced by the type of terrain, river crossing, and state regulations.
- Pipelining is the most economical method for transporting large quantities of CO_2 over land.
- Factors Influencing the Cost of Pipeline
  - Pipe diameter
  - Pipeline operating pressure
  - Length of pipeline
  - Type of terrain traversed
  - Country/region regulations with regard to pipelines
  - Size and spacing of booster stations

Pipeline Costs Have Risen in Recent Years



Average of large-diameter gas pipelines 30 to 36 inches FERC data compiled by Oil & Gas Journal

CO2 Pipelines Operate at Higher Pressures than Natural Gas Pipelines and Would be More Expensive

	Outside Diameter	Max Stress	Class Coeff.	Max Pressure	Final Thickness	Inside Diameter	Tons per Mile	Steel Cost $/mile cost @500/Ton	Steel Cost $/mile cost @900/Ton	Steel Cost $/inch-mile cost @500/Ton	Steel Cost $/inch-mile cost @900/Ton
Natural Gas	12.75	70,000	0.6	1,000	0.375	12.00	130	65,238	117,428	5,117	9,210
Natural Gas	16	70,000	0.6	1,000	0.375	15.25	165	82,371	148,268	5,148	9,267
Natural Gas	24	70,000	0.6	1,000	0.500	23.00	330	165,182	297,327	6,883	12,389
Natural Gas	30	70,000	0.6	1,000	0.625	28.75	516	258,096	464,573	8,603	15,486
Natural Gas	36	70,000	0.6	1,000	0.750	34.50	743	371,658	668,985	10,324	18,583
Natural Gas	42	70,000	0.6	1,000	0.875	40.25	1,012	505,868	910,563	12,044	21,680
Carbon Dioxide	12.75	70,000	0.6	2,200	0.375	12.00	130	65,238	117,428	5,117	9,210
Carbon Dioxide	16	70,000	0.6	2,200	0.419	15.16	184	91,787	165,217	5,737	10,326
Carbon Dioxide	24	70,000	0.6	2,200	0.629	22.74	413	206,521	371,737	8,605	15,489
Carbon Dioxide	30	70,000	0.6	2,200	0.786	28.43	645	322,688	580,839	10,756	19,361
Carbon Dioxide	36	70,000	0.6	2,200	0.943	34.11	929	464,671	836,409	12,908	23,234
Carbon Dioxide	42	70,000	0.6	2,200	1.100	39.80	1,265	632,469	1,138,445	15,059	27,106

Barriers to Widespread Deployment Conclusion

- While there are no significant barriers to building the forecasted pipeline mileage, the major challenges to implementing CCS are in public policy and regulation.
- Because a CCS industry can evolve in several ways, public policy decisions must address key questions about industry structure, government support of early development, regulatory models, and operating rules.

- Bottom line: Such issues must be resolved before necessary investments in a CCS pipeline system can be made.

- INGAA Foundation Study: **Carbon Sequestration and Storage: Developing a Transportation Infrastructure, 2009:** Focuses on the pipeline infrastructure requirements for CCS.
- The major conclusion of the study is that while CCS technologies are relatively well defined, there remain technological challenges in the carbon capture and sequestration phases, and less so in transportation. Carbon capture is the most significant cost in the CCS process. The study forecasts that the amount of pipeline that will be needed to transport CO_2 will be between 15,000 miles and 66,000 miles by 2030, depending on how much CO_2 must be sequestered and the degree to which enhanced oil recovery (EOR) is involved.